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Annual Distribution and Preliminary Characterization of Beluga (*Delphinapterus leucas*) Habitats in the St. Lawrence

R. Michaud[1], A. Vézina[1], N. Rondeau[2] and Y. Vigneault

Department of Fisheries and Oceans
Fisheries and Habitat Management Branch
Fish Habitat Management Division
Champlain Harbour Station
P.O. Box 15,500,901, Cap Diamant,
Québec, Qc, G1K 7Y7

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R. Michaud[1], A. Vézina[1], N. Rondeau[2] and Y. Vigneault

Department of Fisheries and Oceans
Fisheries and Habitat Management Branch
Fish Habitat Management Division
Champlain Harbour Station
P. O. Box 15500
901 Cap Diamant
Quebec, Que.
G1K 7Y7

Current addresses:

1. Institut national d'Ecotoxicologie du Saint-Laurent, 310 Ave. des Ursulines, Rimouski, Que. G5L 3A1
2. Lapel, Groupe-Conseil Inc., 1305 Lebourgneuf Blvd., Quebec, Que. G2K 2E4

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Abstract

Michaud, R., A. Vézina, N. Rondeau and Y. Vigneault. 1990. Annual Distribution and Preliminary Characterization of Beluga (*Delphinapterus leucas*) Habitats in the St. Lawrence.Canadian Technical Report of Fisheries and Aquatic Sciences No. 1757, v + 31 p.

This study is a compilation of historical and contemporary information on the distribution of beluga whales in the St. Lawrence Estuary and Saguenay Fjord. The references used are existing scientific publications, along with unpublished data obtained from prominent research scientists and privileged observers.

Seasonal distribution patterns showing the major changes over the past century are shown. Analysis of sighting reports and available oceanographic data allow determination of preliminary boundaries and characteristics of the main beluga habitats. Type of habitat use and physico/chemical characteristics are also described.

Résumé

Michaud, R., A. Vézina, N. Rondeau et Y. Vigneault, 1990. Distribution annuelle et caractérisation préliminaire des habitats du béluga (*Delphinapterus leucas*) du Saint-Laurent. Rapp. tech. can. sci. halieut. aquat. 1756: v+31p.

La présente étude dresse un bilan des informations historiques et contemporaines sur la distribution des bélugas dans l'estuaire du Saint-Laurent et le fjord du Saguenay. Les références utilisées sont les publications scientifiques existantes de même que les données inédites obtenues auprès des principaux chercheurs et des observateurs prévilégiés.

Des patrons de distributions saisonnières faisant ressortir les principales modifications survenues au cours du siècle dernier, sont proposés. L'analyse des données d'observation et des données océanographiques disponibles permet de procéder à la délimitation et à une caractérisation préliminaire des principaux habitats fréquentés par le béluga. La vocation de l'habitat, de même que les conditions physico-chimiques qui y prévalent, sont mises en lumière.

Preface

This study was conducted as a part of the St. Lawrence Action Plan, Conservation component, more specifically under the Status of Environment and Ecosystems Program, for the Fisheries and Habitat Management Branch, Habitat Management Division of Fisheries and Oceans Canada.

This report is a summary version prepared by Procéan Inc. of the study report presented by LAPEL, Groupe-conseil Inc. of Quebec in collaboration with the Institut national d'Ecotoxicologie du Saint-Laurent of Rimouski. The complete report may be consulted by contacting the Department.

INTRODUCTION

The beluga, ***Delphinapterus leucas***, is an odontocete of the family Monodontidae, living in Arctic and near-Arctic waters. Its world distribution is circumpolar. The beluga population of the St. Lawrence is at the southern limit of the species's range. Beluga bones found in marine deposits in the Champlain Sea indicate that beluga have been in the St. Lawrence for at least 10,500 years (Harington and Occhietti 1988).

When the Europeans arrived, commercial hunting of this population was added to the subsistence hunting already practised by the Montagnais Indians (Reeves and Mitchell 1984). The resulting intensive hunting reached its peak in the 1720s and continued until the 1950s. In 1979, the Canadian government passed a regulation making the beluga of the St. Lawrence a protected population and banning all forms of hunting.

Recent aerial censuses indicate that the population is now between 350 and 750 whales (Pippard and Malcolm 1978; Laurin 1982b; Sergeant 1986; Béland *et al.* 1987; Michaud 1988; Sergeant and Hoek 1988). Based on this estimate of population size and cumulative data on beluga catches (1866-1960), Reeves and Mitchell (1984) calculated that the 1885 population must have been at least 5,000. This means that the current population is only 10% of what it was at the turn of the century. Although none of the censuses mentioned above gives any indication of an upward trend in population, their results do suggest that the population has not yet begun to recover, despite the fact that intensive hunting was banned in the 1950s.

Reeves and Mitchell (1984) and Pippard (1985b) reviewed the hypotheses formulated to account for this failure to recover. Some hypotheses suggested intrinsic factors such as an imbalance in the age structure of the population, physiological and behavioural limitations affecting reproduction and a decrease below the critical level. Another series of hypotheses refers to environmental factors such as loss of habitat, harassment and contamination by toxic substances.

A thorough understanding of the beluga distribution in the St. Lawrence is a key factor in developing strategies to protect and monitor this population. The purpose of this study is to recap historical and recent data on the distribution of belugas in the St. Lawrence. Based on this summary, we describe the probable limits of the beluga's annual and seasonal distribution for the first half of this century and for the current period (1973-1989).

MATERIALS AND METHODS

HISTORICAL DISTRIBUTION

The first effort to delimit the distribution of belugas in the St. Lawrence was by Vladykov in 1938 and 1939, and this is the only historical information available to us. The historical distribution maps in this report are thus taken from his monograph on the hunting, biology and economic value of beluga (Vladykov 1944). Additional historical information on the presence of belugas in the St. Lawrence in the 17th and 18th centuries comes mainly from the review of archives by Reeves and Mitchell (1984) and a series of interviews by L. Pippard, H. Malcolm and A. McFarlane from 1977 to 1982 (Pippard 1989).

PRESENT DISTRIBUTION

The choice of 1973 as the beginning of the current period corresponds to the first aerial censuses conducted by Sergeant (1978) and the first field studies by Laurin (1982a) at the mouth of the Saguenay.

Sources

The main sources of information consulted for this study were located through97 a review of the literature and a series of meetings with researchers involved in work on beluga since 1973. It should be noted that much of the information collected to date on the beluga of the St. Lawrence has not yet been published and is contained only in reports or unpublished databases. It is for this reason that the assistance of various researchers (in the form of interview4qs) appeared essential.

The researchers and observers interviewed to establish the recent distribution of beluga were:

D. Sergeant
W. Hoek, Fisheries and Oceans Canada
J. Laurin, Kétos
L. Pippard
H. Malcolm
R. Sears, Mingan Island Cetaceans Study Inc. (MICS)
E. Lynas
P. Béland, Institut national d'Ecotoxicologie du Saint-Laurent
R. Michaud, Institut national d'Ecotoxicologie du Saint-Laurent
M. Kingsley, Fisheries and Oceans Canada

as well as naturalists and ferry officers assigned to the area.

Determining the range

To delimit the beluga's present range, we compiled and combined observations by various researchers during aerial censuses. The observations used were obtained during systematic aerial surveys covering a major part of the middle and marine estuary. These flights were carried out by different organizations and are not directly comparable. The upstream and downstream limits of flight plans varied and some did not cover the Saguenay River.

As well, almost all flights took place during the summer. As a result, the observations obtained by the volunteer observer network form a major source of information to determine fall, winter and spring distribution.

For each season, reported sightings outside the limits of the range proposed in this report were treated as spot sightings (see Appendix). The relatively small numbers involved made it possible to map them. The distributions described do not include all sightings, but rather indicate known regular use areas. The limits proposed are thus minimums and represent the current state of knowledge.

Distribution pattern

All data collected were analysed to obtain a summary description of the distribution pattern of beluga. We were looking here at the distribution of types of groups (pods) and herds over the entire range. These groups and herds have been described in terms of composition (proportions of different age and sex groups) and structure (average, minimum and maximum size of groups and herds).

By group, we mean a number of individuals swimming side by side in the same direction or exhibiting the same behaviour. The distance between individuals in the group is normally no more than one body-length. Single individuals are considered as groups of one. Herds are made up of several groups.

The data used were collected during aerial surveys and also from observations during studies from boats or the coast. Due to the small number of observations during the fall, winter and spring, it was only possible to give a detailed description of summer distribution.

HABITAT BOUNDARIES

The combined mapping of all observations from aerial censuses served to identify the areas most commonly used by beluga. Analysis of other sources of data then enabled us to check regularity of use and in some cases the type of use of these areas by the beluga. The habitat identification and boundaries shown here are based on data of different types, and we do not have all the information necessary to identify particular functions or the exact limits of these habitats.

The proposed habitat boundaries are thus preliminary and must be seen as the starting point for future studies.

CHARACTERIZATION OF HABITATS

The information available on characterization for each of the habitats proposed, has been classified according to the type of use by the beluga and on the basis of physical, chemical and biological factors.

Use of habitats

The results of systematic observations by different researchers (Ketos 1989; Laurin 1982a; Michaud 1987; Pippard 1985a; Sergeant 1986) were analysed to extract the maximum amount of reliable, comparable information on the use of each habitat. In addition to the composition and structure of groups and herds discussed above, we attempted to estimate the frequency of use for each habitat. These estimates are presented as levels of use, expressed as the percentage of overflights during which beluga were seen within the boundaries of a given habitat. Information on type of behaviour and activities observed in each habitat was also studied.

Physico/chemical parameters

Physico/chemical parameters used were: depth, type of substrate, water temperature and salinity, current and the presence of bores and areas of upwelling. These various factors have been mentioned by a number of researchers in an attempt to account for the dynamics of distribution among several cetacean species (Gaskin 1968; Hui 1979; Würsig and Würsig 1979; Fraker *et al.* 1979; Norris and Dohl 1980b; Shane 1980; Smith and Gaskin 1983; Watts and Gaskin 1985).

Minimum and maximum habitat depths were determined using nautical charts from the Canadian Hydrographic Service. Where a habitat bordered on the shoreline, the minimum depth was set at 5 m. According to Pippard (1985a), beluga are rarely observed at depths shallower than this in the St. Lawrence Estuary.

Tidal Current Charts (Canadian Hydrographic Service 1985) were the only source of information used to determine the speed and direction of currents within the habitat boundaries. Although these data date back to the 1930s, they form the only data base for which information from comparable sources is available for almost all of the beluga range. The tidal current chart could not be applied directly for some measuring stations located outside the habitat boundaries. In these cases, the figures shown are estimates based on two or three stations located nearby. The tidal current chart does not cover the Saguenay River.

Information on other physico/chemical parameters came from various sources mentioned in a reference bibliography (Lavallin 1989).

Biological parameters

Biological parameters of interest for habitat characterization refer mainly to the availability and abundance of presumed beluga prey in the St. Lawrence. All the prey identified by Vladykov (1946) in the study on the stomach contents of beluga in the late 1930s were therefore considered. Since all seasons were not covered, the list of prey observed may well be incomplete. For the purposes of this study,four fish species considered likely to

form part of the diet of beluga (herring, smelt, eel and stickleback) were added to the list.

RESULTS AND DISCUSSION

HISTORICAL DISTRIBUTION

Beluga have probably occupied the St. Lawrence uninterruptedly since the last ice age. Native people, followed by European settlers, hunted this resource, which must have seemed inexhaustible at the time. The first brush weir was set up at Kamouraska in 1701, and over the next twenty years a number of other weirs appeared between Cap Maillard and Tadoussac (Reeves and Mitchell 1984). Hunting success varied considerably from year to year. Father Casgrain (1880) reported exceptional catches of 500 beluga in one tide at the Rivière Ouelle and 1800 in one season at the same site. Of all the brush weirs, only those at Ile aux Coudres and Rivière Ouelle remained in operation until 1927 and 1940 respectively.

Downstream from Tadoussac, fishing was mainly from small craft, particularly at Les Escoumins and on the Manicouagan Bank. The methods used were apparently effective, since between 1931 and 1937, during which years a bounty was paid for every beluga killed, 1826 animals were killed between Les Escoumins and Manicouagan Point (Vladykov 1944). Shortly after, in 1938 and 1939, the Quebec Maritime Fisheries Department mandated Dr. Vladykov to assess the impact of beluga on commercial fish stocks.

Vladykov (1944) identified the mouth of the Saguenay as the centre of beluga abundance (Figure 1) on the north shore of the St. Lawrence. The main abundance area extended from Ile aux Coudres to Pointe-des-Monts, with a zone of concentration between the Manicouagan and Bersimis Rivers. Beluga also visited certain areas downstream and upstream of this zone on a seasonal basis. In the fall, they might go as far as 30 miles upstream of Quebec City and right to Chicoutimi on the Saguenay River. In the spring, they could be found right in the Chaleur Bay and in the summer as far as Natashquan. Vladykov (1944) felt these movements were linked to prey. In the winter, the beluga apparently sought ice-free areas with strong current, such as Tadoussac and Godbout.

Vladykov's main sources of information were fishermen, hunters and residents along the shores of the St. Lawrence. Based on their statements, Vladykov concluded there was a substantial increase in the number of white whales in the St. Lawrence between 1927 and 1929. He attributed this increase to the immigration of herds from other regions. His hypothesis was based on a cooling of the waters of the St. Lawrence, coinciding with warming of the waters west of Greenland. According to Vladykov, whales from Greenland were thus forced to migrate towards the cold waters of the Arctic Circle or the St. Lawrence. The fishermen's statements were not, however, corroborated by increased catches during the years in question (Laurin 1982b; Reeves and Mitchell 1984).

Since brush weirs were fixed gear, a poor harvest could just as easily be caused by movement of herds to another area as by a real decline in the population. The increase in the number of beluga between 1927 and 1929 may have coincided with movement of the animals towards areas where fishermen were less used to their presence. This might account for disparity between the proposed increase in population and the hunting success observed. While the comments of fishermen are useful in defining the areas where white whales were present, their estimates of abundance are difficult to use. Fishermen would consider marine mammals competitors and would thus tend to overestimate their numbers, particularly if their fish catches were down, as was the case at the time.

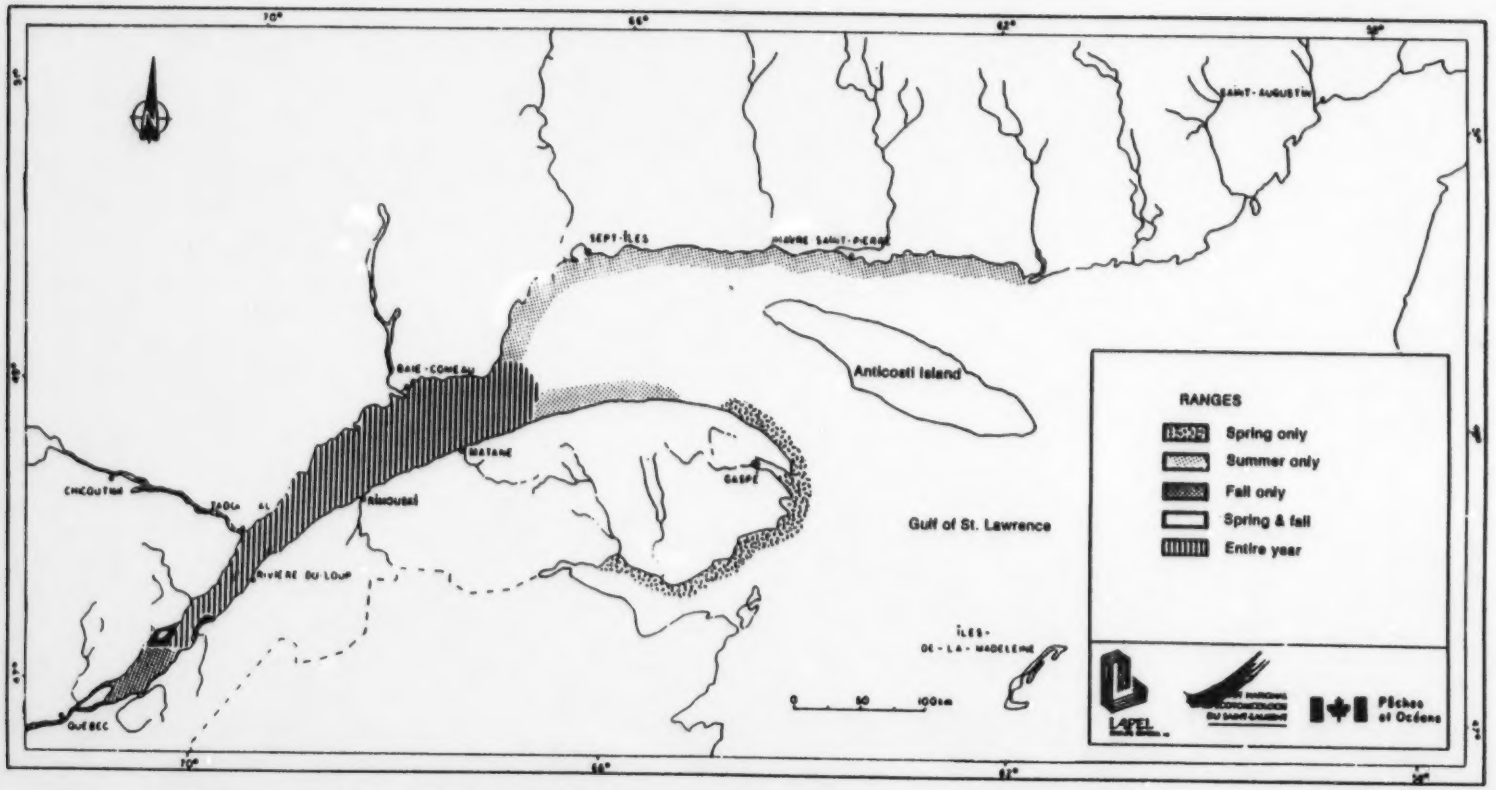

FIGURE 1: BELUGA RANGES IN THE ST.LAWRENCE ACCORDING TO VLADYKOV (1944)

Although the massive immigration hypothesis is difficult to confirm, the fact remains that the possibility of exchanges between the Arctic populations and those of the St. Lawrence exist (Hammill and Smith 1988; Sergeant and Brodie 1969). The distance separating the northern populations and that of the St. Lawrence is no greater than that covered by the beluga of Hudson Bay during their seasonal movements (Hammill and Smith 1988). The beluga sighted at Trinity Bay and Alexander Bay (one individual in each case) on the east coast of Newfoundland in 1938 and 1972 respectively, were possibly from Labrador (Mercer 1973; Sergeant and Fisher 1957). Conversely, the beluga occasionally observed since the 17th century along the coasts of the Maritime Provinces and New England might come from the St. Lawrence (Reeves and Katona 1980; Sergeant *et al.* 1970), These individuals probably followed the Gaspé Current, while animals from the Arctic would have followed the Labrador Current. To enter the St. Lawrence, these whales just had to follow the Strait of Belle Isle.

In the past, exchanges between populations possibly enabled the St. Lawrence population to withstand the periods of intense hunting of the past two hundred years. The trend had long been exploitation rather than conservation, In 1944, Vladykov suggested that a well-organized hunt might take up to 1,000 beluga a year (Vladykov 1944). He added, however, that he did not know whether this level of harvesting "would not jeopardize replacement of these animals". His recommendations were never implemented. Beginning in 1945, hunting declined considerably, and the population might have been expected to recover, which it did not.

PRESENT DISTRIBUTION

Annual and seasonal ranges

Sergeant (1978) used the results of three aerial surveys carried out in 1973 to propose limits for the seasonal ranges of beluga in the St. Lawrence. He suggested the mouth of the Saguenay as the centre point of the summer range, with St. Siméon and Les Escoumins as the upstream and downstream limits on the north shore, and St. André de Kamouraska and St. Simon on the south shore. In the spring and fall, the range extended upstream to Ile aux Coudres. For the winter range, he used the distribution proposed by Vladykov (1944).

Pippard and Malcolm (1978) suggested that the annual abundance area extended from Ile aux Coudres to Les Escoumins on the north shore, from Rivière Ouelle to Rimouski on the south shore and as far as St. Marguerite Bay in the Saguenay River. These authors considered that most of the beluga spent the summer between Ile aux Lièvres and the Grandes Bergeronnes.

During the years that followed, there were few systematic efforts to study the presence of beluga outside the main summer range as described by Sergeant (1986) and Pippard (1985a). The results of aerial surveys by Michaud in 1987 and 1988 indicated that almost a quarter of the population spent the summer in the area between Cap Maillard and Gros Cap à l'Aigle (Michaud 1988), an area located upstream of the limits of the summer range proposed by earlier researchers.

Summer range

For the summer range, we propose the Batture aux Loups Marins (eastern tip of the Montmagny archipelago) as the upstream limit and St. Simon as the downstream limit on the south shore, and Les Escoumins on the north shore. In the Saguenay, the upstream limit is set at St. Fulgence. Although there has been only one aerial survey covering this part of the Saguenay (Michaud, unpublished data), sightings are quite often reported by volunteer observers, particularly in July and August (Béland and Michaud, unpublished data; Laurin 1982a) (Figure 2).

The Manicouagan Banks, a major beluga habitat in the 1940s (Vladykov 1944),

are no longer part of the summer range. Sergeant saw no beluga during aerial surveys in 1973, and the fact that the beluga had left this sector was confirmed by subsequent aerial surveys (Kingsley, pers. comm.; Sergeant 1978; Pippard and Malcolm 1978; Sears and Bérubé 1986).

Some researchers have ascribed the disappearance of beluga from this area to the construction of the Manicouagan-Outardes power dam in the 1960s (Laurin 1982b; Pippard 1985b; Sergeant and Brodie 1975).

Damming these rivers has changed their flow. In the case of the Manicouagan, the flow decreased from 3000 m^3/s to 500 m^3/s, and the temperature dropped from 6-7°C to 2-3°C (Neu quoted by Sergeant and Brodie 1975). These new conditions may have interfered with the beluga's activities, causing them to leave the area (Laurin 1982b; Pippard 1985b; Sergeant and Brodie 1975). It is also possible that the population decreased for completely unrelated reasons, resulting in a shrinking of the range. Whatever the cause, it is impossible to verify these hypotheses, since we have no data on the presence of beluga before and after construction of the dam.

Sporadic surveys on the Middle and Lower North Shore and along the Gaspé coast seem to indicate that, on the whole, the beluga have also left these areas, which Vladykov had included in the summer range. In an aerial survey extending up to Moisie Bay in October 1977, Pippard and Malcolm (1978) saw no beluga downstream of Pointe-aux-Anglais. Sears, who flew over the Middle and Lower North Shore on several occasions between 1980 and 1986, reported only a few sightings, at the St. Augustin River, Corrosol and Moisie (Sears, pers. comm.). Belugas were also observed at Blanc-Sablon and Sheldrake (Béland and Michaud, unpublished data; Pippard 1985b).

Winter range

The winter range proposed is the same as that described by Vladykov (1944) (Figures 1 and 2). It coincides with the limits of the marine estuary, i.e. the mouth of the Saguenay to Pointe-des-Monts. Sightings of large herds have often been reported off Grandes Bergeronnes during the winter (Béland and Michaud, unpublished data; Pippard and Malcolm 1978). During this period, the beluga appear to extend their range downstream. Officers on the Matane-Baie Comeau/Godbout ferry have reported seeing herds of 10 to 75 whales in the winter. These reports have been corroborated by other observers stationed along the coast (Béland and Michaud, unpublished data). One observer reported seeing beluga regularly along the North Shore when flying over the estuary between Baie Comeau and Matane between 1975 and 1980 (Béland and Michaud, unpublished data). In an aerial survey by Michaud on March 13, 1989, no animals were sighted between Quebec and Les Escoumins. In a second flight on March 19 of the same year, most of the 118 beluga sighted were along the south shore between Ile Verte and Les Méchins (Michaud, unpublished data). Flights by Kingsley (pers. comm.) during the same period confirm these sightings.

Spring range

During his last flight in March 1989, Michaud observed 64 belugas along the Gaspé coast from Ste-Anne-des-Monts to Cloridorme. These sightings were, however, treated as three spot sightings (see Appendix). With the exception of these reports and a few others between winter and spring, we have records of very few spring sightings outside the limits of the summer range.

Gaspé fishermen interviewed in 1978, (Pippard and Malcolm) claim they still see beluga early in the spring. As well officers on ferries at Ile aux Coudres, Rivière-du-Loup and Tadoussac all began sighting beluga in their area on the same day, March 30 (Béland and Michaud, unpublished data).

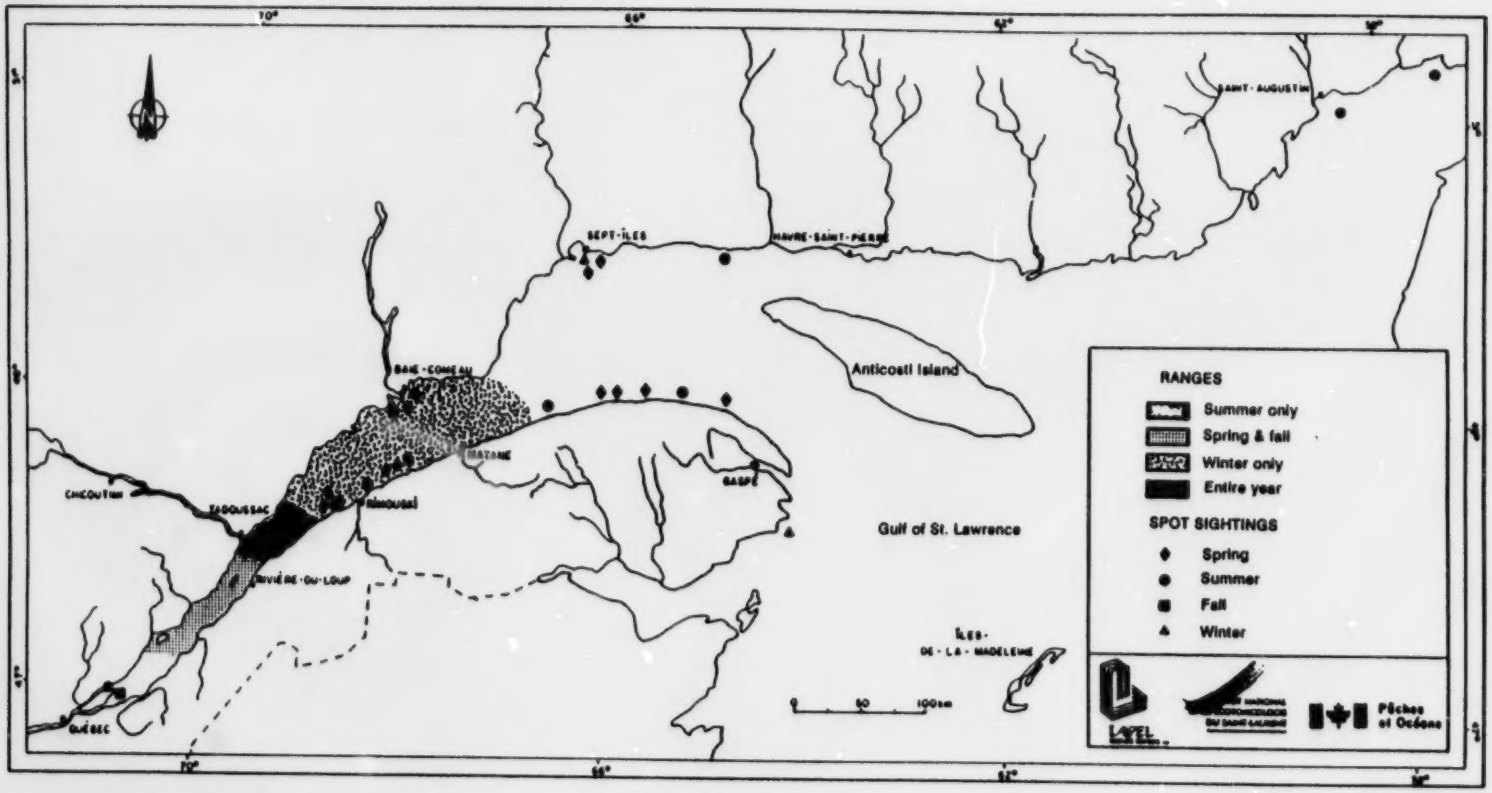

FIGURE 2: ANNUAL AND SEASONAL RANGES OF BELUGA IN THE ST. LAWRENCE

Although belugas are sighted quite early in the spring in the marine estuary and occasionally along the Gaspé coast, it nevertheless appears that these whales are inside the limits of their summer range. Apart from sightings in late March and early April, there are more sightings of beluga downstream of Les Escoumins in the summer than in the spring (see Appendix). The data available for the moment does not allow us to propose a spring range that would be different from the summer range (Figure 2).

Fall range

Due to lack of data, we are currently unable to show a fall range different from the summer range (Figure 2). Only one sighting is recorded downstream of the summer limits (see Appendix). In the fall, as in the spring, the limit of the range in the Saguenay River is at St. Marguerite Bay, halfway to the boundary of the summer range.

Sightings outside limits

As in the past, belugas are occasionally sighted along the coasts of the Maritime Provinces and New England. Although such sightings are reported in all seasons, they are more frequent in the summer (Figure 3 and Appendix).

Distribution pattern

The distribution of beluga in the St. Lawrence Estuary is of the aggregate type. A number of researchers (Sergeant and Hoek 1988; Pippard 1985a; Laurin 1982a; Michaud, in prep.) have noted a segregation of the population by age group and sex during the summer. In the downstream portion of the summer range, we find large concentrations of adults, presumed to be mostly males. In the rest of the range (upstream), we find a non-uniform distribution of smaller herds made up of both adults and young. In these herds, the adults seem to be mainly females with their young. For the part of the summer distribution between the upstream limit (Batture aux Loups marins) and the mouth of the Saguenay, Michaud (in prep.) estimated the percentage of juveniles at between 35% and 45%. These percentages are relatively stable from one part of this sector to another. Data supplied by Sergeant (1986) and Pippard and Malcolm (1978) indicate a lower percentage of juveniles in the Saguenay River, around 25%. Although there is no systematic survey to assist in evaluating the percentages of juveniles in the Grandes Bergeronnes area, Michaud (unpublished data) estimated that it would vary more widely than elsewhere, possibly between 0 and 10%.

The size distribution of groups and herds is also quite uniform (Michaud, in prep.). Beluga herds observed in the downstream portion of the summer range, particularly on the north shore of the Estuary (Grandes Bergeronnes area) had an average of 111.7 (±80.7) individuals. Elsewhere in the range, the average size of herds was fairly small, varying from 13.5 (±17.6) to 19.0 (±14.9), with a slight peak for the Saguenay River at 22.7 (±13.1) and a very small number for the Ile aux Lièvres and Ile aux Fraises area, at 7.4 (±6.5) individuals per herd (Michaud, in prep.)

The same uniformity is found in the size distribution of groups sighted. The average size of groups is 4.6 (±3.9) individuals in the Grandes Bergeronnes area and varies between 1.9 (±1.1) and 2.6 (±2.5) in the Saguenay River and near its mouth (around Batture aux Alouettes and Ile Rouge). In the entire upstream sector, from Ile aux Lièvres to Ile aux Coudres, and from the south side of the downstream portion (Trois Pistoles sector), it varies from 1.2 (±0.5) to 1.6 (±1.6) individuals per group.

The make-up of herds using a given sector is valuable information for determining the protection to be given to a particular habitat. If we consider that an increase of the beluga population of the St. Lawrence is largely dependent on the adult stage recruitment rate, then considerable attention must be paid to areas heavily used by young beluga.

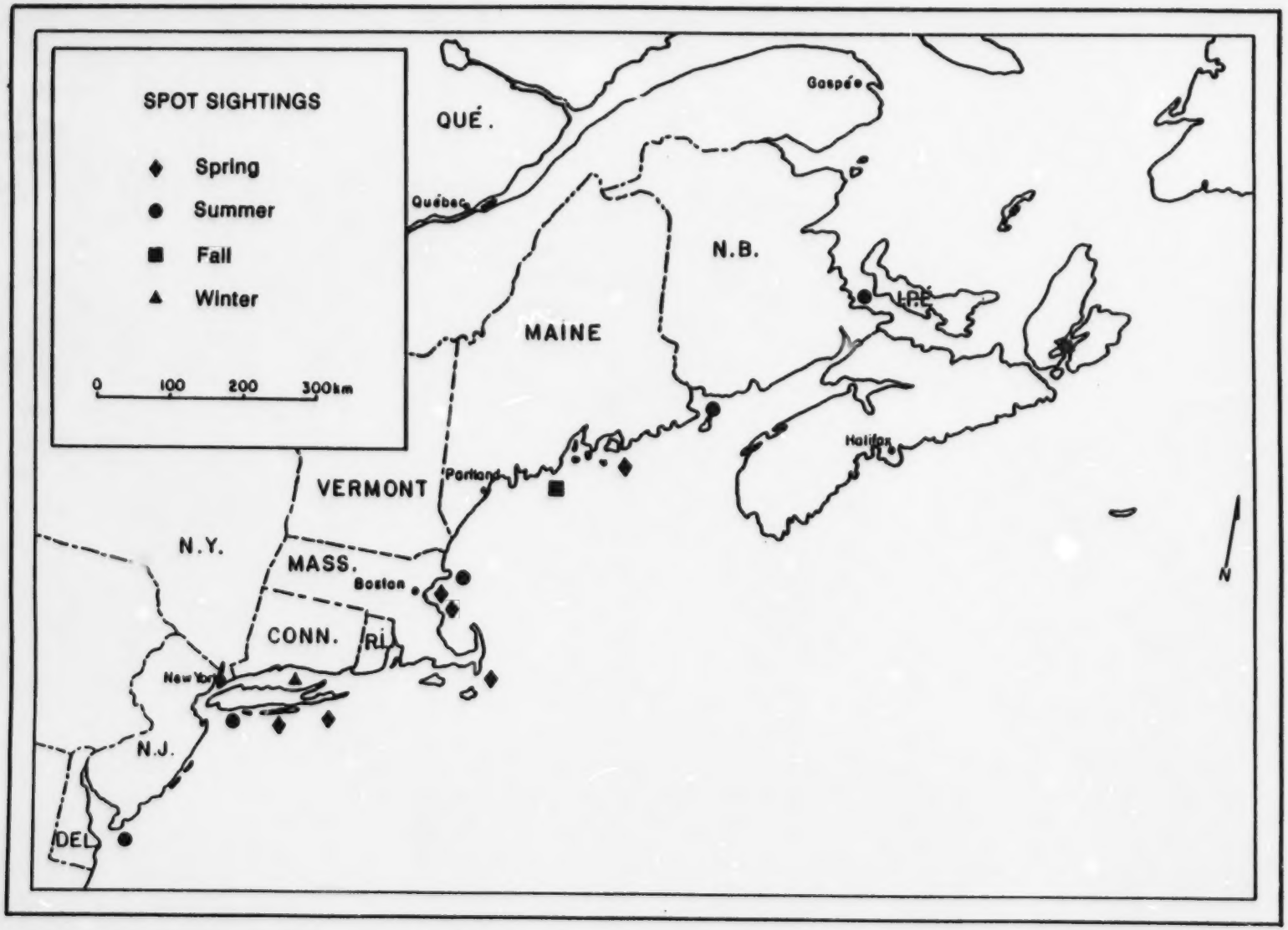

FIGURE 3: BELUGA SIGHTINGS OUTSIDE SEASONAL RANGE (1974-1988)

As well, the structure of groups and herds observed in a sector may be an indication of the type of use the beluga make of that sector. Different group or herd sizes may, for example, reflect different food search and capture strategies or different social activities. Although for the moment we have no systematic study that establishes these relations among the beluga of the St. Lawrence, this type of relation has already been established for a number of cetacean and land mammal species (Jarman 1974; Irvine *et al.* 1979; Norris and Dohl 1980a, 1980b; Whitehead and Moore 1982; Würsig and Würsig 1980).

HABITAT BOUNDARIES

In all, 17 habitats have been identified (Table 1). Only one is not specifically used during the summer: the Ile aux Coudres Passage, which is mainly frequented in the spring. The 16 other habitats are included in the summer range.

Based on the type and quantity of data available, the habitats have been classified as presumed habitats or possible habitats. Presumed habitats are those for which we have a set of data obtained during sustained, systematic observation and/or directed observations covering several years and confirming regular use of the area by beluga. The other areas were classified as possible habitats if available sightings covered only a few years but were also from reliable sources. The level of use, defined as the percentage of overflights during which beluga were sighted in a habitat, was also used to distinguish between presumed and possible habitats. For all summer habitats, this rate varied from 25% to 89% (Table 2). In general, habitats for which the rate was 60% or greater were classified as presumed habitats.

Areas with the highest levels of use were the Kamouraska Islands, Ile aux Fraises and Pilier de l'Ile Blanche. These habitats had levels of 89% (N=18 flights), 82% (N-11) and 78% (N=9) respectively.

CHARACTERIZATION OF HABITATS

Habitat use

The level of use discussed above is one of the factors used in characterizing habitat use. Although this rate provides a measure of the relative importance of a sector for beluga, it is neither the only indicator nor the one that tells us the most about the value of the habitat.

Despite a fairly low level of use (25%), St. Marguerite Bay, in the Saguenay River area, appears to be an important habitat for beluga.

Repeated sightings by several researchers (Pippard and Malcolm; Sergeant; Michaud) over a number of years (1975 to 1988) indicate that belugas visit this sector regularly and tend to remain there for fairly long periods, up to 16 hours (Michaud, unpublished data). Residence time may be another valid indicator of the importance of a given sector for the beluga. This factor pinpoints the routes used by the belugas in sectors they seek out for specific activities.

Data on the composition and structure of groups and herds are factors that characterize habitat use, and no statistical analyses have been made of their characterization in terms of type of activities.

Pippard and Malcolm (1978), defined these habitats as areas of concentration where one or more of the following behaviours had been observed: feeding, resting, socialization or movement. St. Marguerite Bay, the mouth of the Saguenay, the Grandes Bergeronnes area, L'Anse aux Basques and the area to the south of Ile aux Lièvres were identified by Pippard and Malcolm as feeding and resting areas, St. Catherine Bay, Ile Rouge and the northeastern part of Ile Rouge as feeding, resting and movement areas, and the Prince Shoal as a feeding and movement area.

Table 1 List of beluga habitats in the St.Lawrence

Habitats	Note
Ile aux Coudres sector (summer)	
Su1 Traverse St-Roch	possible habitat
La Malbaie sector (summer)	
Su2 Cap-aux-Oies	possible habitat
Su3 Rivière-Ouelle	possible habitat
Su4 Iles de Kamouraska	presumed habitat
Su5 Gros-Cap-à-l'Aigle	possible habitat
Ile aux Lièvres sector (summer)	
Su6 Ile-aux-Fraises	presumed habitat
Su7 Sud de l'Ile-aux-Lièvres	presumed habitat
Su8 Nord de l'Ile Blanche	possible habitat
Ile Rouge sector (summer)	
Su9 Pilier de l'Ile blanche	presumed habitat
Su10 Batture-aux-Alouettes	presumed habitat
Su14 Sud de l'Ile rouge	possible habitat
Su15 Ile Verte	presumed habitat
Su16 Grandes Bergeronnes (secteur)	presumed habitat
Saguenay sector (summer)	
Su11 Embouchure du Saguenay	presumed habitat
Su12 Anse St-Etienne (Saguenay)	presumed habitat
Su13 Baie Ste-Marguerite (Saguenay)	presumed habitat
Ile aux Coudres sector (spring)	
Sp1 Passage de l'Ile-aux-Coudres	possible habitat

Source: this study

Table 2 Summary of information on habitat use by beluga

Habitats	Level of use (no. of flights)	Activities observed	Average size of herd (no of herds)	Average size of group (no of herds)	Composition % juveniles (no of individuals)
Sp1 Ile aux Coudres Passage	N/D	N/D	N/D	N/D	N/D
Su1 St.Roch crossing	44% (n=16)	Movement	19,0 ± 14,9(1) (n=37)	1,3 ± 0,9(1) (n=392)	N/D
Su2 Cap aux Oies	40% (n=15)	Feeding	16,5 ± 13,5(2) (n=70)	1,2 ± 0,5(2) (n=847)	N/D
Su3 Rivière Ouelle	47% (n=15)	N/D	16,5 ± 13,5(2) (n=70)	1,2 ± 0,5(2) (n=847)	N/D
Su4 Iles de Kamouraska	88,9% (n=18)	N/D	16,5 ± 13,5(2) (n=70)	1,2 ± 0,5(2) (n=847)	N/D
Su5 Gros Cap à l'Aigle	44% (n=18)	N/D	16,5 ± 13,5(2) (n=70)	1,2 ± 0,5(2) (n=847)	N/D
Su6 Ile aux Fraises	82% (n=11)	N/D	7,4 ± 6,5(2) (n=27)	1,2 ± 0,5(2) (n=847)	36,7%(1) (n=116)
Su7 South of Ile aux Lièvres	64% (n=11)	Resting calving	7,4 ± 6,5(2) (n=27)	1,6 ± 0,9(1) (n=114)	46%(1) (n=149)
Su8 North of Ile Blanche	44% (n=9)	N/D	7,4 ± 6,5(2) (n=27)	N/D	N/D
Su9 Pilier de l'Ile Blanche	78% (n=9)	N/D	17,3 ± 21,5(2) (n=26)	1,2 ± 0,4(1) (n=120)	32,5(1) (n=119)
Su10 Batture aux Alouettes	73% (n=11)	Feeding, resting, calving	17,3 ± 21,5(2) (n=26)	2,6 ± 1,3(1) (n=27)	45%(1) (n=82)
Su11 Mouth of Saguenay	43% (n=7)	Feeding	N/D	N/D	26%(1) (n=2403)
Su12 St.Etienne Cove	29% (n=7)	Feeding	22,7 ± 13,4(2) (n=3)	1,9 ± 1,0(2) (n=33)	N/D
Su13 Bay St.Marguerite	25% (n=7)	Feeding claving	22,7 ± 13,4(2) (n=3)	1,9 ± 1,0(2) (n=33)	N/D
Su14 South of Ile Rouge	40% (n=10)	N/D	17,3 ± 21,5(2) (n=26)	1,6 ± 1,2(1) (n=26)	44,6%(1) (n=42)
Su15 Ile Verte	40% (n=10)	N/D	17,3 ± 21,5(2) (n=26)	1,6 ± 1,2(1) (n=96)	50,6%(1) (n=112)
Su16 Grandes Bergeronnes	70% (n=10)	N/D	107 ± 53 (n=33)	4,6 ± 3,9 (n=87)	N/D

(1) Figures from sampling in habitat
(2) Figures from sampling in habitat area
N/D Not determined
Sources are given in the bibliography

In 1986, Michaud (in prep.) compared the various types of swimming activity of belugas in the eight zones between Ile aux Fraises and the mouth of the Saguenay. He assessed the relative importance of directional activities and activities on the spot (milling). The presence of this behaviour may, as noted above, serve as an indicator for identifying feeding and socialization activities. Michaud observed a positive correlation between the frequency of this behaviour and the level of use of the areas studied. He also observed that levels of use (in terms of the average number of beluga observed per sector) changed with the phases of the tide cycle. The relation between levels of use and the frequency of milling behaviours was valid for all tidal phases. These results indicate the dynamic nature of beluga distribution in the St. Lawrence Estuary and implicitly suggest that distribution of areas appropriate for feeding might also vary considerably.

A summary map and a detailed presentation of information useful in characterizing the use of the various proposed habitats are given in figures 4 to 9.

Physico/chemical characterization

Researchers who have examined the physical and chemical parameters of the St. Lawrence Estuary have most commonly described medium and large-scale phenomena. Given the limited dimensions of the habitats proposed for beluga, it was difficult to find data that would enable us to distinguish the specific characterization of one habitat from those of a neighbouring area.

The following parameters were used: water temperature and salinity, minimum and maximum depths, type of substrate, current and the presence of bores and areas of upwelling.

Temperature data from the Marine Environmental Data Service (MEDS) was not available before this report was prepared. As well, given the significant variations in temperature due to tidal phases and water depth, it was impossible to use the results of independent studies to establish a basis for comparison of temperatures by habitat. The characteristic temperatures of each habitat are thus not given.

The same problem existed for salinity, with the exception of the average salinity figures given by Lavoie and Beaulieu (1971). These cover all of the range and, since they come from a single source, they can be compared. They give a very succinct appreciation of the differences observed throughout the range. These figures do not, however, take into account the wide daily variations in this parameter for a given sector. In the summer range, mean surface salinity in July varied, according to Lavoie and Beaulieu (1971) from 12 0/00 to 25 0/00. It varied from 12 0/00 to 22 0/00 between the St. Roch Crossing and the Kamouraska Islands, increased downstream to 25 0/00 at Ile Rouge and rose as high as 33 0/00 off Tadoussac (Lebel and Pelletier 1980).

The maximum depth of habitats varied from 20 to 285 m. The greatest depths were off Grandes Bergeronnes (Habitat Su16). In the Saguenay River and its mouth (habitats Su11, Su12 and Su13), they varied from 119 to 176 m. For all other habitats, maximum depths were between 20 and 66 m, except for habitats at Gros Cap à l'Aigle (Habitat Su5) and Ile aux Fraises (Habitat Su6), where boundaries are near escarpments where depths reached 115 m and 90 m respectively.

Flood currents in all habitats varied between 0.4 m/s and 3.9 m/s, while ebb currents ranged from 0.6 m/s to 4.1 m/s. At the ebb tide, maximum currents were found in the St. Roch Crossing (Habitat Su1) (4.1 m/s). In the habitats in the Ile aux Coudres Passage (Habitat Sp1), north of Ile Blanche (Habitat Su8) and at Pilier de l'Ile Blanche (Habitat Su9) and south of Ile Rouge (Su14), these currents ranged from 2.1 to 2.4 m/s. Elsewhere, they varied from 1.0 to 1.9 m/s, except off Grandes Bergeronnes (Habitat

Su16), where currents were the slowest (0.6 m/s).

On the inner side, or very close to the habitats in the St. Roch Crossing (Habitat Su1), Cap aux Oies (Habitat Su2), Gros Cap à l'Aigle (Su5), Pilier de l'Ile Blanche (Habitat Su9), Batture aux Alouettes (Habitat Su10), the mouth of the Saguenay (Habitat Su11) and Ile Verte (Habitat Su15), nautical charts show major bores or choppy areas.

Table 3 gives a summary of the physico/chemical characteristics for each habitat. Figures 4 to 9 give this information in the form of a map summary by habitat.

Biological characterization

The rare studies that deal with the distribution or ecology of adult fish assumed to be prey for beluga (herring, capelin, smelt, eel, cod, sole, sand lance, tommy cod and Arctic sculpin) in the St. Lawrence Estuary are mainly qualitative studies that provide no indication of the abundance of these species. The small number of such studies is no doubt due to the low level of commercial fishing in the area. Landing statistics compiled for communities along the shores of the St. Lawrence within the beluga range provide only an approximate indication of the presence of these species, since they cover very large areas. These statistics normally give no estimate of fishing effort and do not specify where the catch was taken. Landing statistics on herring and eel give more detailed information, since these species are caught along the shoreline using fixed gear. The greatest value of this type of statistics is probably to give an indication of the periods during which these two species are abundant in each sector.

There is much more material dealing with the distribution of fish larvae in the estuary. Although there is no evidence of beluga preying on larvae, their distribution was nevertheless considered. We have descriptive studies for the invertebrates (polychaeta, pelecypods, gasteropods, mysidacea, amphipods, decapods, squid, octopus) found in the beluga diet, although these provide few specific details on the presence of taxons for each habitat.

In Table 4, we give an annotated list of some of the presumed prey of beluga for each proposed habitat. Since no detailed survey was made of any of these habitats, the data presented are possibly incomplete. When no information indicated the presence or absence of a species in a given habitat, a blank was left in the table. For other species, where possible, we have specified the different stages present (adult, juvenile, larva).

For each species, we have included a reliability rating. This code does not indicate the quality of the information, but rather provides an indication of where the sample that provided the information was taken. These codes range from 1 to 7 and are described in Table 4. Code 1 applies to data from a sample taken within the habitat, which normally gives the most reliable information. Code 6 refers to information derived from a general description of the species, thus giving less precise information.

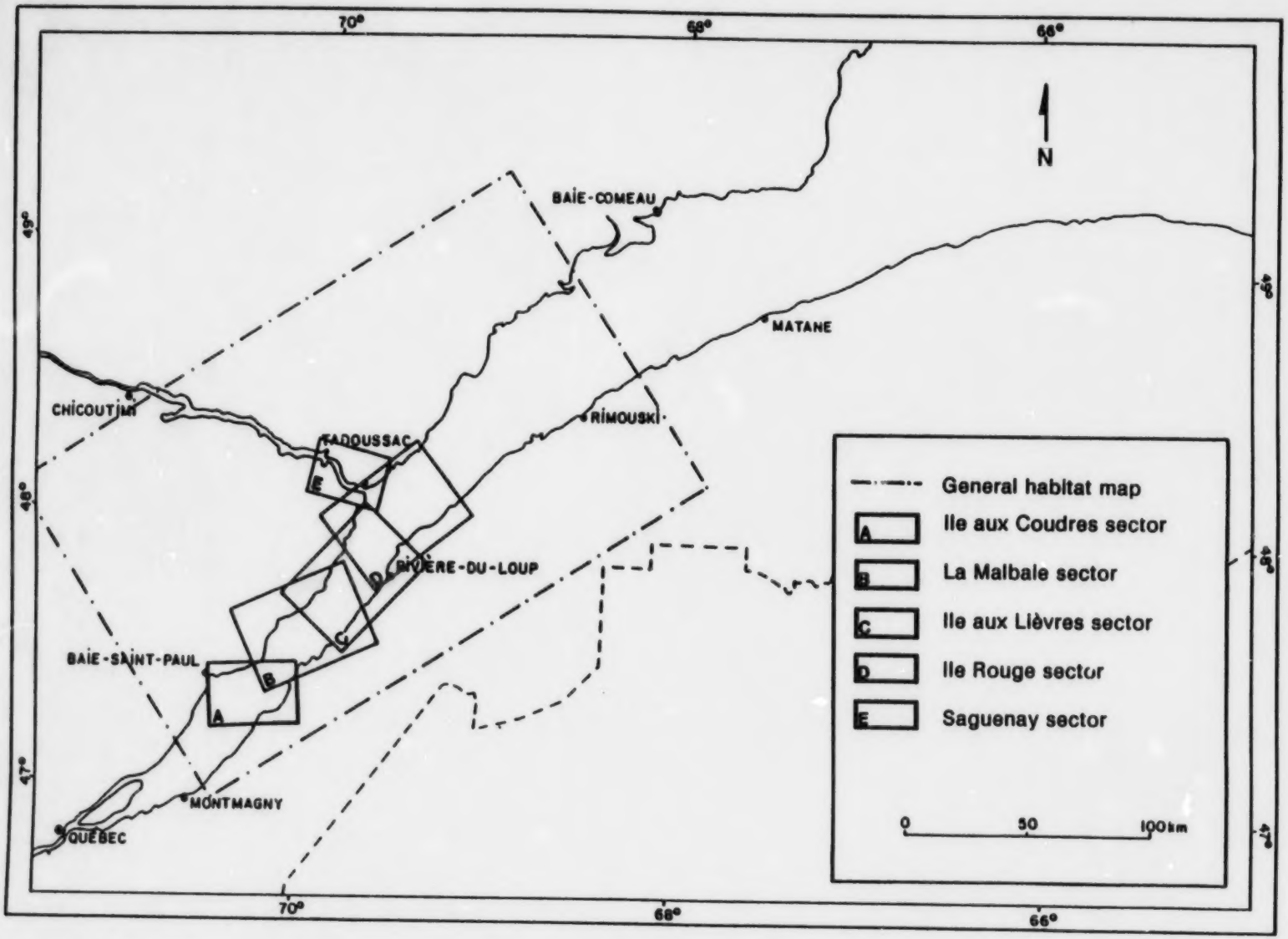

FIGURE 4 MAP INDEX

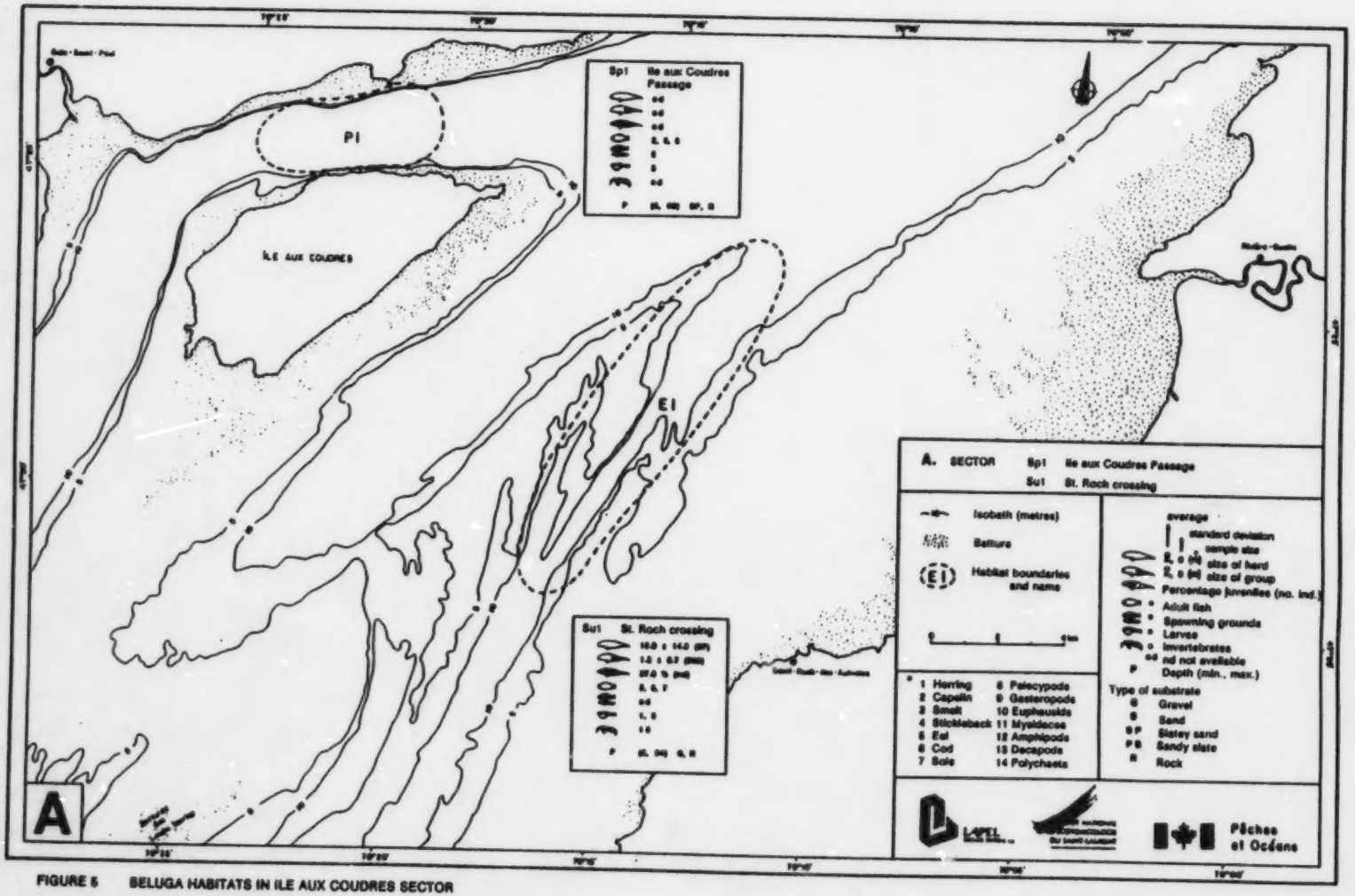

FIGURE 5 BELUGA HABITATS IN ILE AUX COUDRES SECTOR

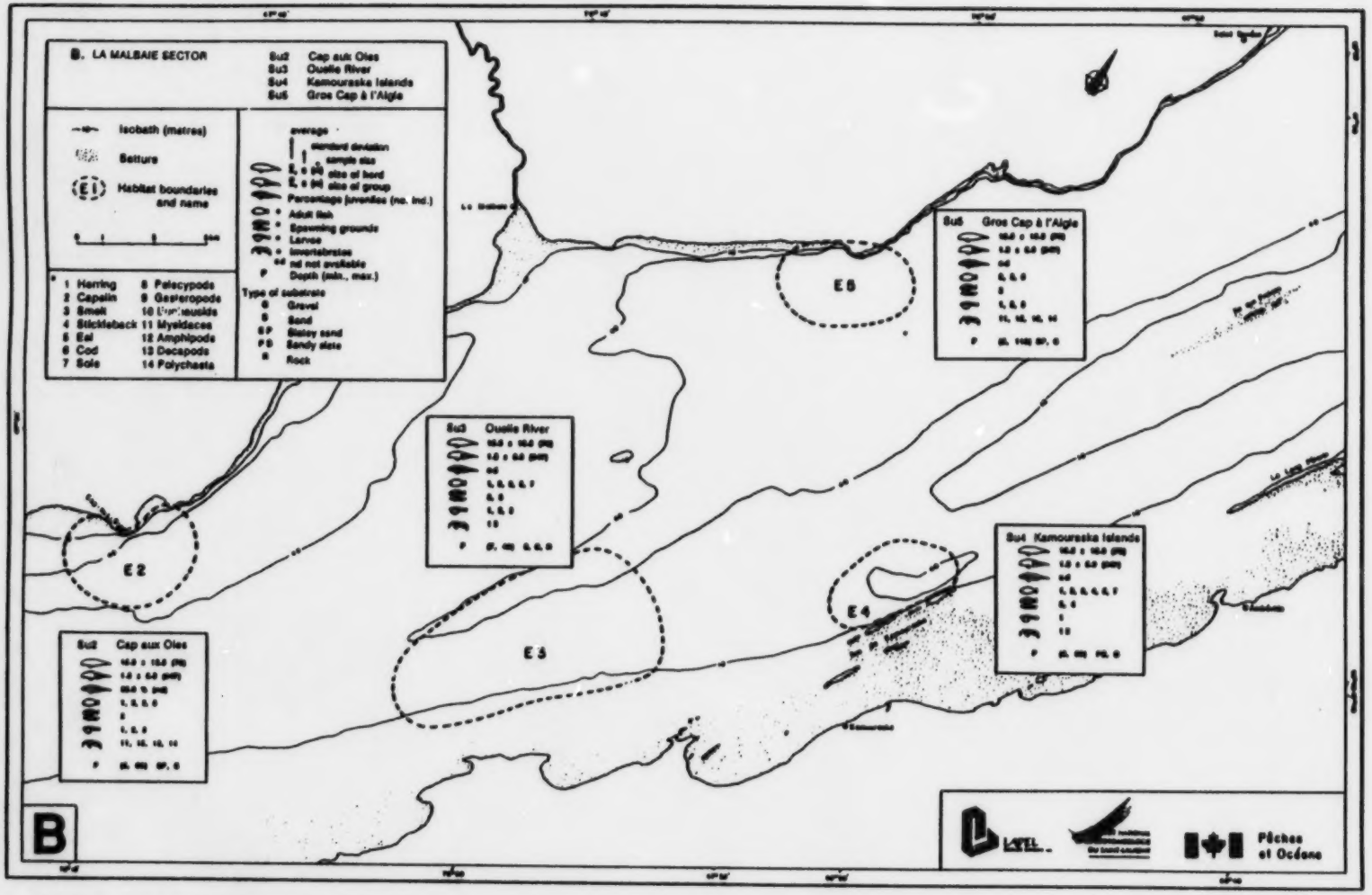

FIGURE 6 BELUGA HABITATS IN LA MALBAIE SECTOR

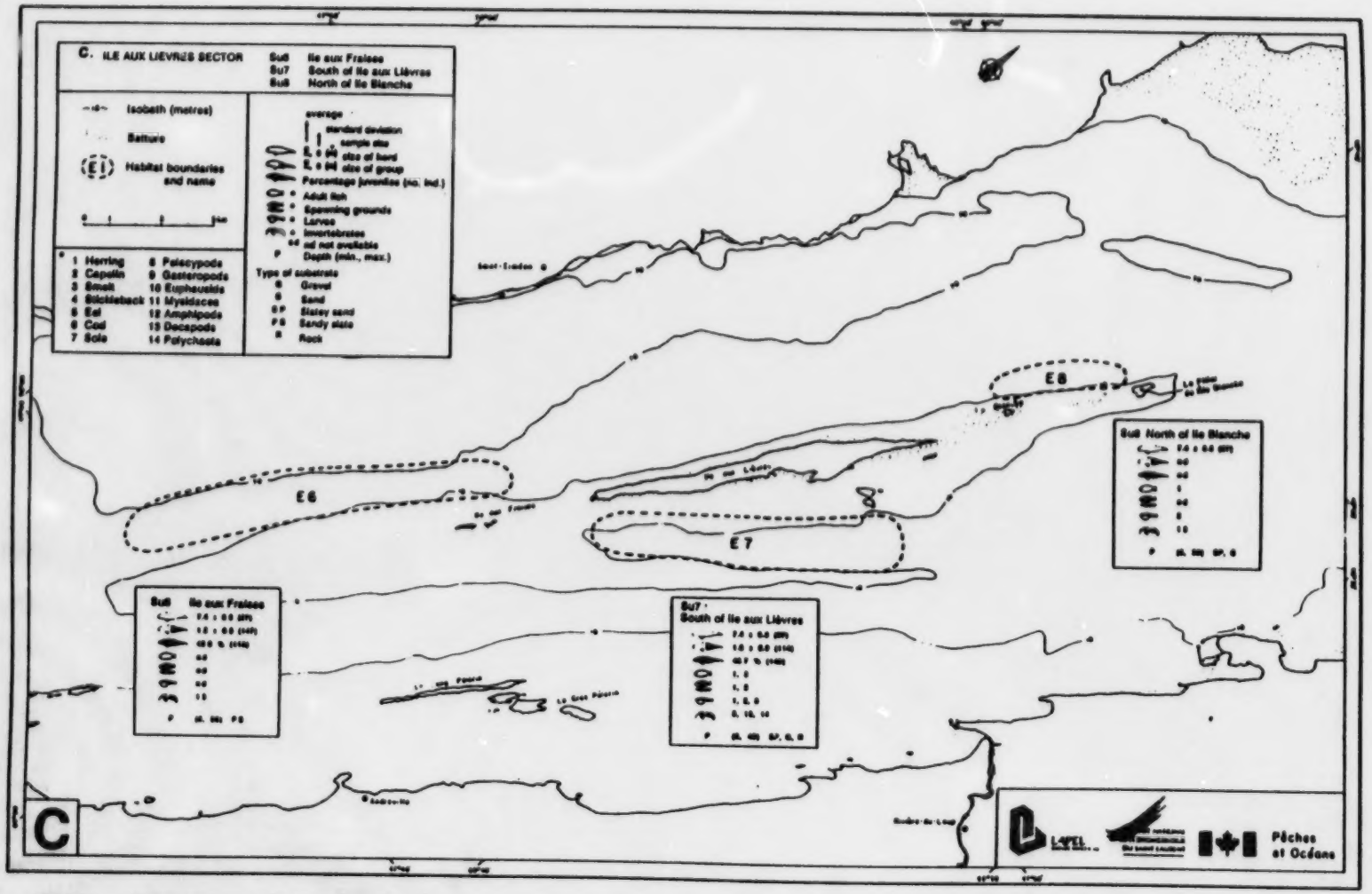

FIGURE 7 BELUGA HABITATS IN ILE AUX LIÈVRES SECTOR

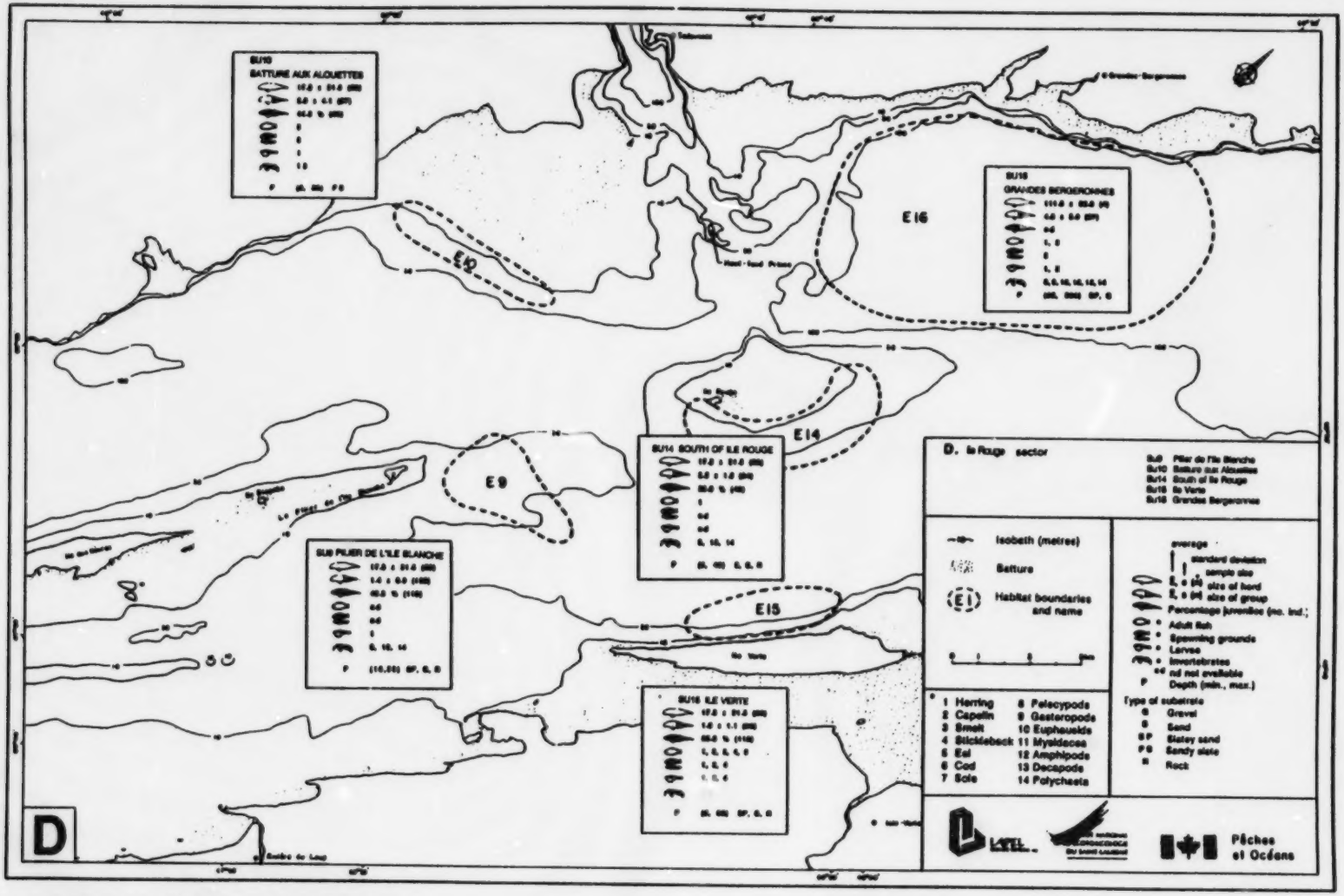

FIGURE 8 BELUGA HABITATS IN ILE ROUGE SECTOR

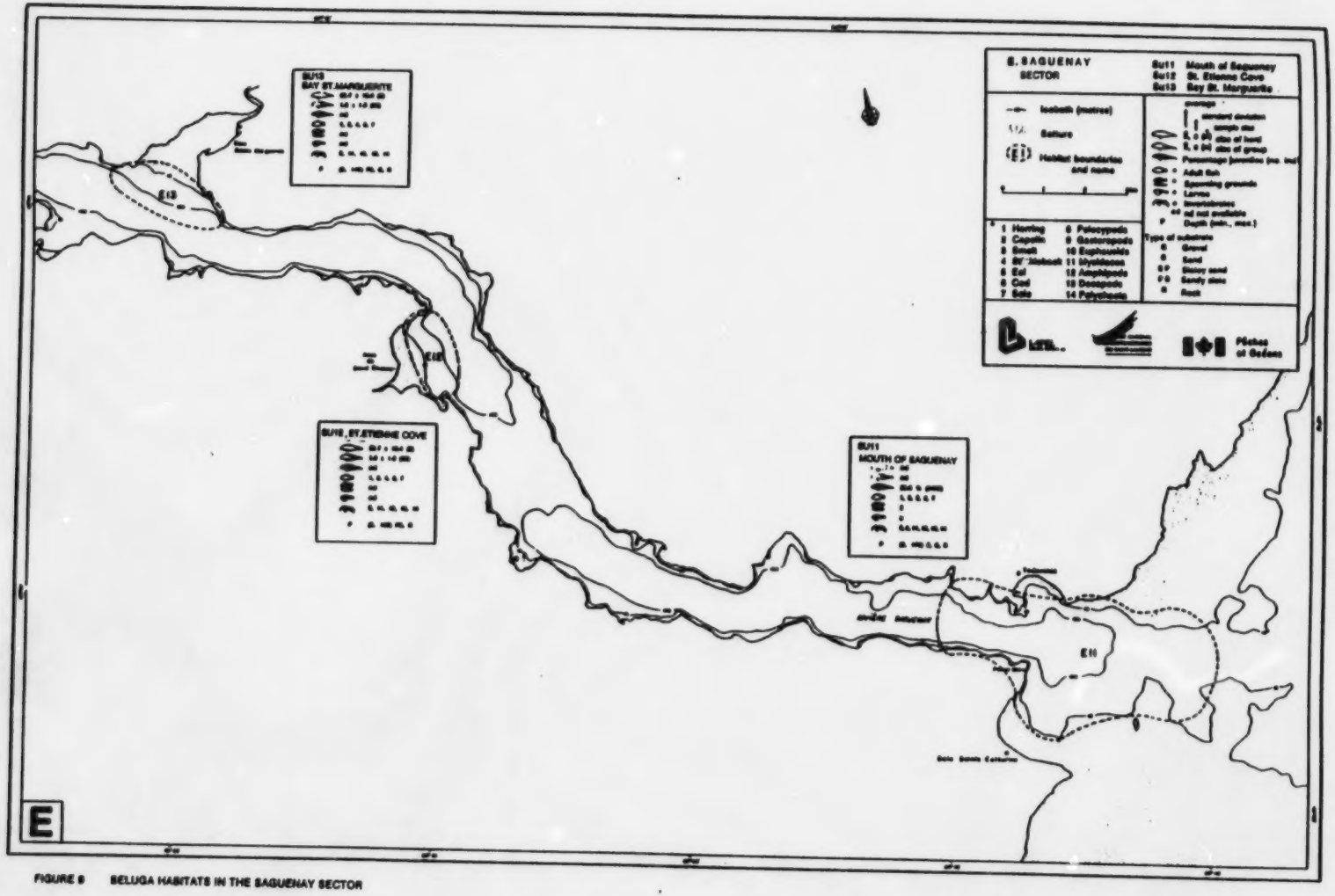

FIGURE 8 BELUGA HABITATS IN THE SAGUENAY SECTOR

Table 3: Physico-chemical characteristics of beluga habitats in the St.Lawrence.

Habitats	Minimum depth (m)	Maximum depth (m)	Type of substrate	Ebb tide		Flood tide		Salinity (0/00)
				Speed (m/s)	Direction (degree)	Speed (m/s)	Direction (degree)	
Sp1 Ile aux Coudres Passage	5	60	SP,R	1,5/2,4	60/78	0,2/1,4	255/273	-
Su1 St.Roch crossing	5	24	G,R	1,4/4,1	-	0,9/3,9	-	12,7
Su2 Cap aux Oies	5	66	SP,G	0,5/1,6	21/52	0,4/1,3	230/260	15,7
Su3 Rivière Ouelle	7	48	S,G,R	0,5/1,4	25/52	0,4/0,9	212/300	19,7
Su4 Kamouraska Islands	5	53	PS,G	0,3/1,0	13/52	0,2/0,5	212/360	22,5
Su5 Gros Cap à l'Aigle	5	115	SP,G	0,6/1,2	28/55	0,2/0,4	185/240	-
Su6 Ile aux Fraises	5	90	PS	0,2/1,2	25/42	0,2/0,9	250/259	22,5
Su7 South of Ile aux Lièvres	5	40	SP,G	0,2/1,3	30/74	0,2/1,2	196/267	20/23
Su8 North of Ile Blanche	5	28	SP,G	0,6/2,1	30/40	0,3/1,3	210/330	23
Su9 Pilier de l'Ile Blanche	15	33	SP,G,R	0,6/2,4	0/73	0,4/1,4	225/292	24,4
Su10 Batture aux Alouettes	5	20	PS	0,2/1,9	10/75	0,3/1,4	208/302	-
Su11 Mouth of Saguenay	5	176	S,G,R	-	-	-	-	19,9
Su12 St.Etienne Cove	5	150	PS,R	-	-	-	-	-
Su13 Bay St.Marguerite	5	119	PS,G,R	-	-	-	-	-
Su14 South of Ile Rouge	5	40	S,G,R	0,3/2,1	30/90	0,3/1,1	114/300	24,2
Su15 Ile Verte	5	60	SP,G,R	0,3/1,8	25/80	0,3/1,0	178/353	24,8
Su16 Grandes Bergeronnes	50	285	SP,G	0,3/0,6	20/70	0,2/0,4	158/186	24,2

Key: G: Gravel PS: Sandy shale S: Sand R: Bedrock

Source: Lavoie and Beaulieu (1971)
Canadian Hydrographic Service (1985)

Table 4: Annotated list of assumed beluga prey for each habitat

Habitats	Herring	Capelin	Smelt	Stickleback	Eel	Cod	Plaice	Pelecypods	Gasteropods	Euphausiids	Mysids	Amphipods	Decapods	Polychaets
Sp1 Ile aux Coudres Passage	A-6 J-6	A-3*	A-1 L-1		A-4	HD		A-6	A-6				A-6	A-6
Su1 St.Roch crossing	A-6 J-6 L-2	HD	A-4 L-1		A-4	HD	A-5	A-6	A-6				A-1	
Su2 Cap aux Oies	A-4 J-6 L-1	A-1* L-1	A-1* L-1		A-4	HD		A-6	A-6		A-1	A-1	A-2	A-1
Su3 Rivière Ouelle	A-5 J-6 L-1	A-3*	A-3* L-1		A-4	HD	A-5	A-6	A-6				A-1	A-6
Su4 Kamouraska Islands	A-1 J-6 L-2	A-3*	A-3*	A-2*	A-3 J-2	HD	A-3	A-6	A-6			A-1	A-6	A-6
Su5 Gros Cap à l'Aigle	A-6 J-6 L-1	A-3* L-1	A-3* L-1		A-4	HD		A-6	A-6		A-1	A-1	A-2	A-1
Su6 Ile aux Fraises	A-6	A-6	A-6			HD		A-6	A-6				A-2	
Su7 South of Ile aux Lièvres	A-1* L-17	A-1* L-2	A-1* L-2			HD		A-6 L-2	A-2				A-1	A-2
Su8 North of Ile Blanche	A-1	A-6 L-1	A-6			HD		A-6	A-6				A-2	
Su9 Pilier de l'Ile Blanche	A-6 L-2	A-6 L-2	A-6			HD		A-6	A-1				A-1	A-1
Su10 Batture aux Alouettes	A-6 J-6 A-2	A-6	A-6		A-6	HD		A-6	A-6				A-1	A-6
Su11 Mouth of Saguenay	A-2	A-1* J-1 L-2	A-2		A-6	A-2	A-2	A-1	A-1	A-6	A-2	A-1	A-2	A-1
Su12 St.Etienne Cove	A-2	HD	A-2	A-2		A-2	A-2	A-1		A-6	A-1	A-2	A-2	A-2
Su13 Bay St.Marguerite	A-2	HD	A-2	A-2		A-2	A-2	A-2		A-6	A-1	A-2	A-2	A-2
Su14 South of Ile Rouge	A-1	A-6	A-6					A-6	A-1				A-1	A-1
Su15 Ile Verte	A-1* J-6 L-1	A-63* L-2	A-61	A-1* L-1	A-4			A-6	A-6				A-6	A-2
Su16 Grandes Bergeronnes	A-5 L-2	A-2* J-7 L-2	A-6		A-6	A-6		A-2	A-1	A-1		A-1	A-1	A-1

Key

Development stage
A Adult
J Juvenile
L Larvae

Reliability rating
1 Sampled in habitat
2 Sampled in area of habitat
3 Sample from commercial fishery
4 Landing statistics
5 Information from fishermen
6 General distribution
7 Undetermined

* Spawning ground
HD Habitat located outside range of species

CONCLUSIONS AND RECOMMENDATIONS

HISTORICAL AND PRESENT RANGES

The main difference between the historical and present ranges may be seen during the summer. The beluga used to be found right out to the mouth of the St. Lawrence Estuary and sporadically along the Lower North Shore and the Gaspé coast. The downstream limit of the summer range is now between Les Escoumins on the North Shore and St. Simon on the South Shore, in the marine estuary. The upstream limits have remained the same, near Ile aux Coudres.

One of the most important changes in the historical distribution is the fact that belugas no longer use the banks of the Manicouagan River during the summer. During the first half of the century, this area was heavily used by belugas. It has been suggested that the beluga left this area because of changes in heat budget and flow regime at the mouth of the Manicouagan and Outardes Rivers caused by the hydroelectric development of the 1960s. The absence of detailed observation of beluga activity in this area and the lack of studies that would verify changes in prey communities that might have influenced the beluga make it impossible to confirm this hypothesis.

All the information collected also suggests that the Lower North Shore and the Gaspé coast have also been abandoned, at least during the summer. This occurrence, along with a shrinking of the summer range, might simply be due to a decrease in the beluga population.

The data available for establishing the current limits of the fall and spring ranges of beluga are not sufficient to indicate differences between these seasons and the summer range. The proposed limits are thus basically the same for the three seasons. The presence of beluga along the Gaspé coast in the spring has yet to be confirmed.

Very few observations have been made in the winter, and the winter range shown here is thus the same as that described by Vladykov (1944), basically covering the marine estuary.

Most of the research to date on the behaviour and distribution of beluga in the St. Lawrence, as well as most censuses, have concentrated on the summer period. Beluga distribution should also be studied during the other seasons. Winter and spring may be critical periods for reproduction. It would also be interesting to check on the behaviour of beluga in relation to ice conditions in the estuary. If there are movements towards the outside of the Gulf or from the north, they are likely to occur outside the summer period.

DISTRIBUTION PATTERN

Data from different researchers on the structure and composition of beluga herds during the summer suggest a high level of segregation between age groups and sexes during the summer; however, the data available do not allow us to make a functional interpretation of this segregation. This type of analysis would require a comparative study of activity in each sector of the summer range for each sex and age group.

A thorough understanding of distribution patterns is essential for planning censuses and monitoring populations.

Particular attention should be paid to study of areas heavily frequented by the younger age groups. If we consider that an increase in the beluga population of the St. Lawrence is strongly dependent on recruitment to the adult population, we should look at the possibility of giving protected status to these areas.

HABITAT BOUNDARIES

Determining the boundaries of proposed habitats is based on observations covering periods of varying length and frequency. These boundaries should be seen as working proposals for future research.

A research program should be undertaken to study beluga distribution patterns in the winter, spring and fall. In the interests of conservation and protection strategy, we should also determine the importance of habitats used during these seasons.

USE OF HABITATS

There are no studies currently available that would enable us to make a detailed comparison of habitat use in terms of activity or length of residence. The structure and composition of groups and herds have, however, been determined for several habitats.

Once we have a more reliable picture of levels of use and the relative importance (in terms of use) of each sector proposed as a habitat, we can then develop a sampling plan covering a number of habitats. A comparative approach using systematic observations to quantify the proportion of time spent in each type of activity and the length of stay in each habitat would enable us to determine the type of use or "function" of each habitat and thus identify critical habitats.

Determining habitat use should be seen as a key element in preparing a conservation and protection plan for the beluga population of the St. Lawrence.

CHARACTERIZATION OF HABITATS

All of the physico/chemical factors, as well as the presence of presumed preys within the limits of beluga habitats, may vary significantly with tidal phases and seasons. These variations, as well as the dynamic nature of beluga distribution, make it difficult to interpret the ecological preferences of this population.

A characterization of beluga habitats should be carried out in parallel with a study of habitat use. Analysis of this data would enable us to determine the relations between the factors measured and the abundance and/or activity of belugas in each habitat.

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Appendix List of beluga sightings outside the seasonal range (1974-1988)

SEASON	AREA	LOCATION	DATE	NUMBER OF BELUGA	SOURCE
Spring	Marine Estuary	Bicquette Light	28-05-86	100	Béland and Michaud unpub. data
Spring	Marine Estuary	Ste-Flavie Qc	03-04-87	1	Béland and Michaud unpub. data
Spring	Marine Estuary	Ste-Flavie Qc	23-03-88	24	Béland and Michaud unpub. data
Spring	Marine Estuary	Pointe Lebel Qc	03-04-87	10	Béland and Michaud unpub. data
Spring	Marine Estuary	Ste-Luce Qc	17-06-87	1	Béland and Michaud unpub. data
Spring	Gulf	Corossol Island	05-77	2	Sears and Williamson, 1982
Spring	Gulf	Moisie Bay Qc	30-03-81	2	Sears and Williamson 1982
Spring	Gulf	Marsoui Qc	23-03-89	14	Michaud unpub. data
Spring	Gulf	Mont-Louis Qc	23-03-89	48	Michaud unpub. data
Spring	Gulf	Cloridorme Qc	23-03-89	2	Michaud unpub. data
Spring	Atlantic	Massachusetts Bay. USA	16-05-88	1	Béland and Michaud unpub. data
Spring	Atlantic	Marble Mass. USA	06-76	1	Reeves and Katona 1980
Spring	Atlantic	Mt. Dessert Island, Maine, USA	09-04-78	1	Reeves and Katona 1980
Spring	Atlantic	Long Island N.Y., USA	03-79 à 06-79	1	Reeves and Katona 1980
Spring	Atlantic	Long Island N.Y., USA	22-06-80	1	Béland and Michaud unpub. data

Appendix(cont'd.) List of beluga sightings outside the seasonal range (1974-1988)

SEASON	AREA	LOCATION	DATE	NUMBER OF BELUGA	SOURCE
Summer	River Estuary	Montmorency Qc	03-08-77	11	Pippard and Malcolm 1978
Summer	Marine Estuary	Rimouski East Qc	09-86	1	Béland and Michaud unpub. data
Summer	Marine Estuary	Manicouagan Qc	21-06-87	1	Béland and Michaud unpub. data
Summer	Marine Estuary	Baie Comeau Qc	02-07-87	1	Béland and Michaud unpub. data
Summer	Gulf	Brasd'Or Lake Cap-Breton,NS	25-06-85	1	Béland and Michaud unpub. data
Summer	Gulf	Sheldrake Qc	10-08-85	1	Béland and Michaud unpub. data
Summer	Gulf	Rivière-la-Madeleine, Qc	08-86	6	Béland and Michaud unpub. data
Summer	Gulf	Shediac NB	29-07-87	1	Béland and Michaud unpub. data
Summer	Gulf	St-Augustin Qc	15-07-83	5-6	Sears unpub. data
Summer	Gulf	Cap-Chat Qc	15-09-77	3	Pippard and Malcolm 1978
Summer	Gulf	Blanc-Sablon Qc	summer 1981	2	Pippard 1985 b
Summer	Atlantic	Marble Mass. USA	20-07-85	1	Béland and Michaud unpub. data
Summer	Atlantic	Back Bay N.B.	24-06-76	2	Reeves and Katona 1980
Summer	Atlantic	Cape May NB	07-78	2	Reeves and Katona 1980
Summer	Atlantic	Suffolk N.Y., USA	18-08-81	1	Béland and Michaud unpub. data

Appendix(cont'd.) List of beluga sightings outside the seasonal range (1974-1988)

SEASON	AREA	LOCATION	DATE	NUMBER OF BELUGA	SOURCE
Fall	River Estuary	Ile d'Orléans Qc	24-09-77	3	Pippard and Malcolm 1978
Fall	River Estuary	La Pérade Qc	03-10-88	3	Béland and Michaud unpub. data
Fall	Marine Estuary	Bic Qc	22-09-88	20	Béland and Michaud unpub. data
Fall	Atlantique	Somes Sound Maine U.S.A.	29-09-74	1	Reeves and Katona, 1980
Winter	Gulf	Grande-Rivière Qc	02-84		Sergeant 1986
Winter	Gulf	Sept-Iles Qc	02-87	1	Béland and Michaud unpub. data
Winter	Atlantique	New Haven Harbor, Ct. U.S.A.	08-02-85	1	Béland and Michaud unpub. data